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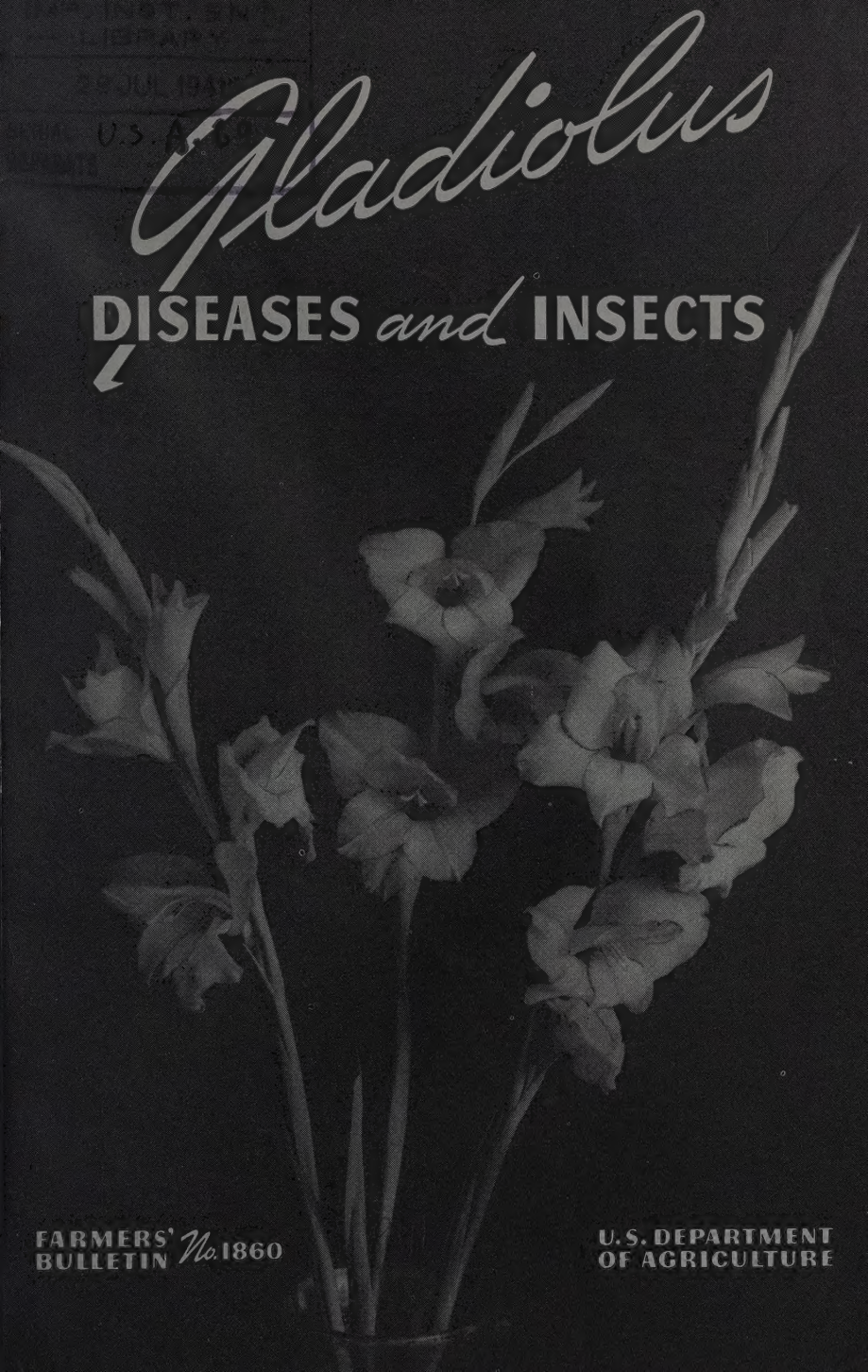
Gladiolus

DISEASES and INSECTS



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GLADIOLUS diseases as now known are a comparatively recent development. How or where these diseases originated is rather obscure. Some may always have existed naturally to a slight extent on gladiolus.

In addition to these natural enemies other types of disease may have migrated from other plants to the gladiolus after it became commonly cultivated. Modern methods in gladiolus culture provide more favorable conditions for diseases and pests than did the wild plants. Also it seems that although culture and breeding have increased the size and beauty of the gladiolus they have tended, in some varieties at least, to lessen its resistance to disease. The intensive cultural conditions, unnatural crowding in plantings and in storage, new varieties susceptible to disease, and the general and extensive distribution of planting stock, all are factors in the increase and spread of diseases in the United States and all the gladiolus-growing regions of the world.

The gladiolus thrips, although not known to occur in the United States prior to 1929, has since its discovery spread rapidly to most of the areas where gladiolus is grown. For a while it threatened the future existence of this popular garden plant. Its rapid spread, like that of many of the gladiolus diseases, was no doubt due to the extensive distribution of planting stock. It still remains the most important insect enemy of gladiolus. Mealybugs, aphids, and some other insects also make trouble for the gladiolus grower.

This bulletin describes several diseases and insect pests of gladiolus, and gives directions for their control.

Washington, D. C. Issued May 1941

GLADIOLUS DISEASES AND INSECTS

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Contents

	Page
Gladiolus diseases	1
Hard rot	1
Scab and leaf blight, or neck rot	2
Dry rot	3
Penicillium rot	4
Fusarium rot	4
Vascular fusarium, or yellows	5
Mosaic	6
Botrytis	6
Leaf blight	6
"Rusty" leaves	7
Leaf spots	7
Gladiolus diseases—Continued.	
Cotton root rot	7
Control of gladiolus diseases	8
Storage	9
Disinfectants	9
Spraying	10
Insect pests of gladiolus	10
Gladiolus thrips	10
Other species of thrips	15
Grape mealybug	16
Tulip bulb aphid and other aphids	17

GLADIOLUS DISEASES

Notes on gladiolus diseases in the United States are found in a few publications before 1900. Evidently there was some known or suspected trouble, but the notices found by the writer are not sufficient to enable one to identify any particular disease. One of the earliest described diseases found by the writer was published in 1909.[1] The symptoms described seem to indicate that the disease was that now known as yellows, or wilt, one of the most widely distributed and destructive diseases of gladiolus. If this is true it is remarkable that the disease attracted little or no attention until about 1920. In 1910 [2] descriptions of hard rot and dry rot were published. Somewhat later scab appeared as the most common disease. As growers became more generally aware of a disease and realized its potential danger, methods of control were devised and used so successfully that in a few years the damage from that particular disease was eliminated or greatly reduced. Unfortunately new types of disease appeared or increased. About 1920 yellows was observed in the West. This disease has gradually spread into all parts of the United States. It is still a menace and causes considerable loss every season. More recently mosaic and botrytis have claimed attention.

HARD ROT

Hard rot (*Septoria gladioli*) is a fungus disease that apparently exists wherever gladioli are grown and is the cause of considerable loss. Corm lesions appear in the fall as water-soaked, more or less circular spots of a reddish-brown to a brownish-black color (fig. 1, *A*). It is usually necessary to remove the husks to find the lesions. As the spot increases in size the center becomes sunken, the color deepens to dark brown or almost black, and the margin becomes more definite, irregular, and somewhat angular in outline. The diseased

[1] Rural New Yorker. 1909. p. 1009.
[2] Rural New Yorker. 1910. p. 355.

tissue is very hard. Frequently the disease advances so far that the corm is reduced to a hard, wrinkled mummy. Diseased plants in the field are more or less dwarfed; they often fail to produce bloom, and may die prematurely. The same fungus may infect the leaves, mostly near the crown, producing irregular, grayish-brown spots with purplish-brown margins and centers beset with small black dots.

The corms become infected in the field, and the source of the infection may be infested soil, diseased parent corms, or diseased foli-

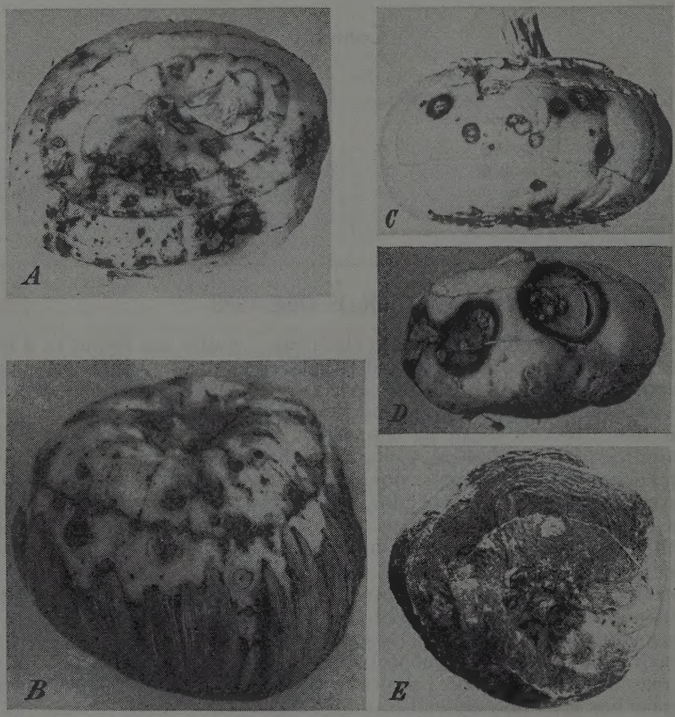

FIGURE 1.—Gladiolus diseases: *A*, Hard rot; *B*, scab; *C*, dry rot; *D*, penicillium rot; *E*, storage rot caused by *Fusarium*. × 1.

age. Individual rot lesions may enlarge rapidly in storage. Spread from infected corms to sound ones in storage is not known to occur, but it is believed possible in cases where infested soil is stored with the corms. Experiments indicate that the fungus causing this disease lives at least 4 years in the soil.

SCAB AND LEAF BLIGHT, OR NECK ROT

Scab and leaf blight, or neck rot (*Bacterium marginatum*), is probably the most common and most widely distributed disease of gladioli. Leaf spots are circular to elliptical, rusty red, becoming dull brown or purplish; they may occur on all parts of the leaf but are usually

confined to the lower part (fig. 2). The leaf infection makes rapid progress only in warm, moist weather. Severely infected plants often break at or near the ground level and fall partly or completely over. Husk lesions are brown to black, circular, or more often elongated holes or cracks. The outer husks are sometimes entirely destroyed along the lower edge where they are attached to the corm. This destruction of the husk, really the base of the leaf, cuts off the supply of moisture and causes yellowing and death of the leaf. On the body of the corm the spots are circular sunken areas, yellow to brown or black and horny in texture. They are easily removed and leave shallow pits (fig. 1, *B*). The lesions often exude a liquid which, when dry, is brittle and shining like varnish. Corms become infected during the growing period, either from infested soil or from infected leaves. This disease does not increase in normal storage, but in the dry lesions of both corms and husks the bacteria remain viable and pathogenic from season to season. If diseased corms are husked, thoroughly disinfected, and planted in soil free from the disease, there seems a better chance of obtaining a clean crop than if the gladioli are attacked by almost any other disease. Disinfectants containing mercury are much more effective in controlling this disease than are those based on sulfur, formaldehyde, or copper.

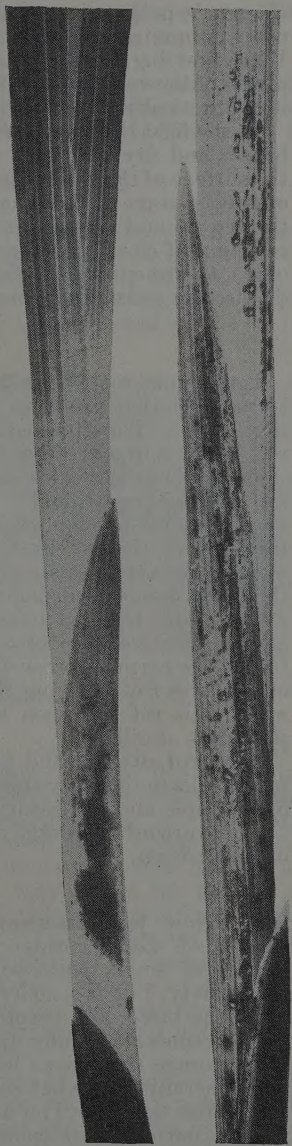

FIGURE 2.—Scab (*Bacterium marginatum*) on gladiolus leaves. × 1.

DRY ROT

When dug, corms infected by dry rot (*Sclerotinia gladioli*) are usually small as compared with the healthy corms, and the husks are dull brown or spotted. The surface of the corm has reddish-brown to black, more or less circular spots, with definite and slightly elevated margins, varying in size from a pin point to half an inch in diameter (fig. 1, *C*). Infection takes place in the field from infested soil or infected parent corms. In storage the

disease is progressive, and a large portion of the affected corms become mummied by spring. Cormels are also subject to this disease. When first dug, the diseased cormels are darker than those from healthy plants of the variety, but after they have been in storage for some weeks it is practically impossible to distinguish them from healthy cormels.

In the field the leaves of infected plants turn yellow, later becoming brown and dry. At this stage the stem decays and often bends at the surface of the soil. Numerous minute black granules, the sclerotia or resting stage of the fungus, are found on the lower parts of many of the leaves and on the husks. Practical experience has shown that selection of clean stock (corms must be husked to detect all diseased ones), treatment with a disinfectant, and planting in soil free from the disease are satisfactory means of keeping this disease in check.

PENICILLIUM ROT

Penicillium rot (*Penicillium gladioli*) is a common and destructive storage rot that produces reddish-brown, sunken spots on the corms (fig. 1, *D*). The diseased tissues are firm but less hard than in hard rot. The surface often has irregular concentric wrinkles, usually some sulfur-yellow color, and, if sufficient moisture is present, a covering of gray-green mold. The small, cream-colored or light-brown, hard sclerotia develop below the surface. Infection apparently enters through injuries received in digging or cleaning. Even very small wounds provide entrance for the fungus, which increases rapidly in the moist tissues, causing rather large rotted areas before the corm is well cured. Care in handling and good storage conditions usually afford effective control. Unless there is extensive destruction of tissue, the corms grow well and produce a clean crop. There is little or no danger of carrying the disease over to the next crop. In cases where this rot has been troublesome, the baskets, trays, etc., used should be sterilized.

Hard rot, dry rot, and penicillium rot infections on the corms look much alike in the early stages, and positive identification often requires microscopic and laboratory methods of examination.

There are other storage rots that are apparently due to other species of *Penicillium*.

FUSARIUM ROT

Fusarium rot (*Fusarium oxysporum* var. *gladioli*) is primarily a disease of stored corms. At harvesttime the lesions on the corms appear as small, water-soaked spots. The later color varies with the variety, but is usually reddish brown to almost black. In some cases the husks are discolored and brittle, but badly diseased corms may be concealed under apparently healthy husks.

In storage the lesions increase in size; they are irregularly circular and generally somewhat sunken owing to the rapid drying and shrinking of the tissues. The advancing margins are usually definite and show a narrow, dark-colored, water-soaked area. The lesions often show prominent, more or less concentric rings or ridges (fig. 1, *E*). By spring the entire corm may be brownish black and dry-rotted. Proper handling of the corms at harvesttime and during storage is

usually sufficient to keep the losses at a minimum. Corms should be well cured, and the storage temperature should be kept at about 35° F.

In the spring the diseased corms should be discarded, and the remainder should be disinfected before being planted. As the fungus lives over in the soil, a 4- to 5-year crop rotation should be practiced.

VASCULAR FUSARIUM, OR YELLOWS

A leaf blight and corm rot caused by a *Fusarium*, which prefers the vascular tissues, at the present time is probably the most serious disease of gladiolus. In the field the plants become pale or yellow. An examination of the corm will show a brown rot beginning at the basal scar, spreading upward into the core and outward to the nodes

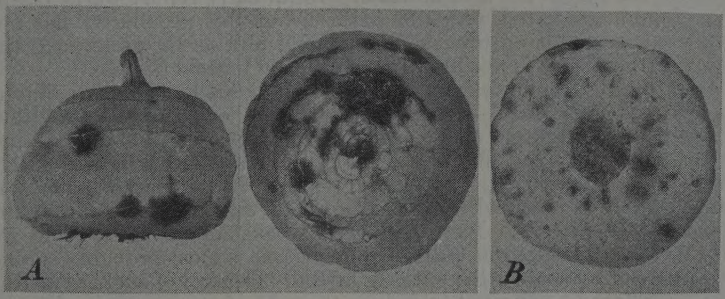

FIGURE 3.—Vascular fusarium disease of gladiolus: *A*, Development of corm rot after storage; *B*, early stages of vascular fusarium rot. × 1.

(leaf bases) and often to the bases of the leaves (fig. 3, *B*). Many plants die, and the corms rot in the ground. With less severe infections the plants may mature and produce new, normal-appearing corms. The disease increases during storage, and in the spring many of the infected corms will have brown spots along the nodes (fig. 3, *A*), or even be entirely rotted. Others may show little or no outward sign of disease but, if planted, may rot in the ground or produce sickly plants or fairly normal plants, depending on the degree of infection in the planting stock. The new corms are more than likely to carry the infection. Elimination of diseased stock, well-drained soil, and dry, cold storage are recommended for the control of this disease. The soil becomes infested with the fungus, and fields where the disease has been prevalent should not be used for several years at least for gladiolus.

Another type of disease apparently caused by a *Fusarium* produces a shallow, hard crust on the base of the corms. The trouble seems to originate in a rough or broken basal scar and has been most often seen in the darker-colored varieties such as War, Crimson Glow, and Anna Eberius. The whole base of the corm is often covered with the thin dark crust which interferes considerably with the root development.

MOSAIC

During the past decade increasingly numerous reports of the breaking of the petal color in gladiolus suggest that a mosaic disease is involved. The virus nature of this disease has not yet been proved by experimental transmission, but the symptoms, distribution, and development of the disease indicate that gladiolus mosaic is of this class. Mosaic has been observed in many varieties and in several States, chiefly in the North. It has been suggested that low temperatures are associated with the appearance of the symptoms and that these effects are suppressed at higher temperatures.

The chief symptom of mosaic in gladiolus consists of white or pale blotches, streaks, or flecks in the petal color, commonly known as "breaking." These pale areas may be small and few, or large and so run together as to cover nearly the whole surface of the petal. Occasionally the leaves are also mottled. In an early report warty corms were found associated with this disease, but this peculiarity has not appeared in recent outbreaks. In general and as far as known, the vigor of the plants is not greatly reduced by mosaic disease.

Because little definite information on gladiolus mosaic is available, suggestions for control must be drawn from experience with other diseases of the mosaic class. It is to be expected that corms and cormels from affected plants will carry the disease, but it is unlikely that true seed carries it. Stocks carrying a low percentage of mosaic can probably be cleaned up by roguing out diseased plants from the flowering-size blocks. Badly diseased stocks and cormels from infected stocks are best discarded. The disease is most probably spread by aphids or by some other sucking insect. Control of sucking insects may therefore be expected to reduce the rate of spread of the disease.

BOTRYTIS

Although known in Europe for 50 years or more as a cause of gladiolus disease, botrytis in the United States is a comparatively new source of trouble requiring notice. During the past 10 years there have been reports of a botrytis foliage disease from various parts of the United States. The leaf spots are pale, dull, reddish-brown blotches or elongated streaks, often of considerable size. The infection has not often been serious, and in some cases there has been doubt whether botrytis was wholly or only partly responsible for the damage. As a storage rot it may be more serious. Corms not sufficiently cured before being stored may be entirely destroyed. In the advanced stages, dark-brown to black sclerotia develop in the rotted areas. Thorough curing and cleaning and dry, cool storage are recommended for stock that is suspected of being infected.

LEAF BLIGHT

Leaf blight (*Bacterium gummisudans*) has been reported so far only from Middle Western States and Canada. The spots are at first narrow, horizontal, translucent, dark green, becoming more or less regularly square or rectangular in shape and finally brown in

color (fig. 4). A copious viscid exudate forms a film or small droplets over the lesions, and in this exudate bits of soil, small insects, and various particles become embedded. Young stock is much more severely attacked than mature plants.

"RUSTY" LEAVES

Gladiolus leaves often have large areas covered with tiny reddish-brown spots. These are usually extremely numerous, producing a generally rusty appearance. Careful observation of the location of the affected areas indicates that the damage probably is due to the action of sunlight on wet leaves. Examination of the leaves before the dew or mist evaporates or after gentle rains shows that only those leaves or parts of leaves in a position to hold tiny drops of moisture develop the rust. With each drop of moisture acting as a lens, the leaf would be burned in just as many tiny spots as there are drops if the sun's rays come from the proper direction. Microscopic examinations of the "rusty" spots show damaged and darkened cells, but no disease organisms. This "rust" is not to be confused with somewhat similar symptoms caused by red spiders (mites).

LEAF SPOTS

In addition to the spots caused by the diseases already mentioned, there are various other types of leaf spot. Some are due to parasitic fungi, others to saprophytic fungi following injuries to the leaf tissues. When leaf spots occur early in the season or in unusual abundance some fungicide such as bordeaux mixture (5–5–50) should be applied.

COTTON ROOT ROT

Many growers, especially in the South, send specimens suspected of having cotton root rot disease, but so far the disease has always proved to be something else. Cotton root rot caused by *Phymatotrichum omnivorum* has not yet been reported on gladioli, and inoculation experiments have failed to induce infection.

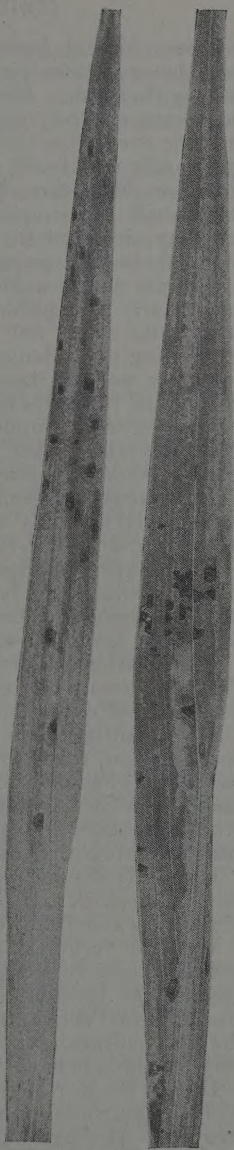

FIGURE 4.—Leaf blight (*Bacterium gummisudans*) on gladiolus leaves. × 1.

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CONTROL OF GLADIOLUS DISEASES

Corms should be handled carefully at all times. Even slight wounds or bruises provide entrance places for infection that may destroy the corm. Prompt drying after digging is important. Unless the weather is very dry, corms should not remain in the field on the ground; even then they should be protected from dew. As soon as sufficiently cured, the corms should be cleaned. The removal of the old corm with the adhering soil and discarding the diseased new corms will aid in preventing infection during storage. Improper handling, incomplete curing, and poor storage conditions are responsible for a large proportion of gladiolus diseases.

Certain varieties having rather tender, easily injured corms are particularly susceptible to penicillium rot. If these varieties can be kept quite warm (80° to 90° F.) for a week or more immediately after being dug, chances for infection will be less. The fungus does not grow well at these temperatures, and the corm tissues harden, so that the fungus is not able to enter.

It is especially important that the corms of varieties subject to fusarium rots, which seem to be causing an increasing amount of trouble, should be cleaned as soon as they are sufficiently cured. The old corms and some new ones are often badly infected and should be removed as early as possible. The good corms should then be stored in a dry, well-ventilated place.

The planting of clean, healthy corms in soil not contaminated with disease germs is the best insurance against disease. However, some gladiolus diseases, especially scab, are so common that it is not always possible to avoid infested soil.

For planting use only corms that appear to be free from disease. To make certain of this point, it is necessary to remove the husks, as hard rot and dry rot lesions often are entirely hidden beneath them.

After planting stock that is free from all manifestation of disease has been selected, the corms of all sizes should be treated in a disinfecting solution. Gladioli should not be planted in the same soil oftener than once every 4 years. Scab, hard rot, dry rot, fusarium rots, and probably others are capable of living over in the soil for an undetermined number of years.

If slightly diseased stock is used it should be planted at a distance from clean stock and all precautions taken to prevent the transference of soil or water from the infected to clean areas.

Valuable varieties may have the diseased parts cut out if they are not too extensive. The corms should then be soaked in a disinfectant. Disease can be eliminated in one or more seasons by using only the least diseased corms, by thorough disinfection, and by making sure of the best cultural conditions possible. However, unless the stock is very valuable it is not worth the trouble.

During the growing season plants showing signs of disease, together with the surrounding soil, should be removed from the field and destroyed. At digging time diseased plants, with their cormels, should be discarded.

After digging, all refuse, such as tops and discarded corms, should be removed and either burned or buried deeply.

STORAGE

The best storage conditions for preventing diseases are known only in a general way. The corms must be kept dry, and the storage room must be ventilated to keep the air free from excessive moisture, especially during the first few weeks of storage. A temperature of 35° to 45° F. is generally recommended.

Corms should not be piled in deep layers. Trays with slat or wire netting bottoms that permit free circulation of air should be used. If the trays are stacked, blocks should be placed so as to leave an air space of an inch or more between them, or they may be placed in racks on shelves, or on runners, with ample air circulation above and below. Good ventilation is very important. Too dry an atmosphere is less harmful than one too moist.

DISINFECTANTS

Experiments thus far have shown no beneficial effect from the application of bordeaux mixture, mercury bichloride, or organic mercury liquid treatments to the soil either before or during the growing season as a preventive of corm diseases. The injection of tear gas (chloropicrin) into the soil, especially for small areas and for elimination of *Fusarium*, offers promising possibilities. Disinfecting treatments have not proved effective when applied to the corms just before they were placed in storage, with a view to preventing the spread of disease during this period. It may even be stated as a rule that wetting the corms at this time is disadvantageous rather than helpful. This does not mean that disinfectants are without value, for they do destroy the parasites on the surface of corms, in the husks, and in particles of adhering soil.

Disinfectants are ordinarily used at planting time, and the corms are planted while damp. If the planting is delayed for any reason the corms can be drained and held for some days without injury. At any time after curing, corms can be safely treated with liquid disinfectants if they are carefully dried before being returned to storage. Gladiolus corms, when dormant, are unusually tolerant of disinfectants. They are not appreciably injured by treatments at the standard concentrations used for disinfection of seeds, potato tubers, etc., even for much longer than the ordinary period; nevertheless, injury may occur if corms that have begun to sprout are treated with fungicides. The recommendations given in the following paragraphs are based on the experience of a number of growers and pathologists and apply only to fully dormant stock. In general, the organic mercury disinfectants can be used with less risk of injury to corms, but in some cases the fungicidal effect is also less.

Mercuric chloride (corrosive sublimate).—Make a 1-to-1,000 solution (1 ounce to 7½ gallons of water). If the tablet form as sold for disinfecting purposes by drug stores is used, dissolve 1 tablet in 1 pint of water to make a 1-to-1,000 solution. Soak the corms for 30 minutes to 2 hours. Some growers soak the corms for 8 to 10 hours. A stronger solution, 1 to 600 (1 ounce to 4½ gallons of water) is often used. It seems to be more effective, and the time of treatment can

be shortened. Metal containers should not be used because more or less of the mercury is deposited on the metal, thus weakening the solution. Discard the solution after using it, or add one-third the original amount of the mercuric chloride. *Mercuric chloride is a poison, and care should be used to prevent the poisoning of persons (especially children) or animals. Discarded solutions should be turned into the sewer or into waste ground.*

Mercurous chloride (calomel).—Use ½ to 6 ounces in 1 gallon of water. The former is the least amount recommended, and 6 ounces is probably more than is necessary. Experiments to date indicate that 2 to 4 ounces in a gallon of water is sufficient for good results. This chemical does not dissolve in water, but by constant stirring can be kept in suspension. Dip the corms in and out of the mixture for several minutes, the purpose being to cover them with a thin, even layer of the insoluble calomel. Drain and plant.

Organic mercury compounds (Semesan, etc.).—Use as recommended by the manufacturers.

SPRAYING

For control of the hard rot or other diseases on the foliage of gladiolus the use of bordeaux mixture plus a sticker consisting of 2 pounds of resin and 1 pound of sal soda crystals, dissolved by boiling in a gallon of water and added to 50 gallons of the 5–5–50 bordeaux mixture, has been advised. This spray might also be effective against the bacterial leaf blights.

INSECT PESTS OF GLADIOLUS

The gladiolus plant and the stored corm (commonly called bulb) are often subject to attack by several kinds of insects which, if not controlled, may cause serious damage. The gladiolus thrips is the most important and widespread insect enemy of gladiolus, with the grape mealybug and the tulip bulb aphid ranking next in importance. In addition there are a number of other pests that occasionally attack gladiolus, such as the corn earworm, cutworms, red spiders, blister beetles, the spotted cucumber beetle, and a few other insects that have a wide range of food plants. However, their attacks on the gladiolus are sporadic, and because of their minor importance as pests of this host they are not discussed in this bulletin.

GLADIOLUS THRIPS

Description of the Thrips

The gladiolus thrips (*Taeniothrips simplex* (Morison)) was first found in the United States near Cleveland, Ohio, in 1929. Since that time it has spread to practically all the gladiolus-growing areas of the country. It is a very small, slender insect measuring about 1/25 to 1/16 of an inch in length, which feeds on the corms, leaves, buds, and flowers of the gladiolus (fig. 5). It has four stages of development, namely, the adult, egg, larva, and pupa. Only the adult and larval stages cause injury to the plants. Several species of thrips may feed on gladiolus at the same time, but the gladiolus thrips, when present,

is always the most injurious and in the adult stage is distinguishable from the other thrips commonly encountered by its white wing bases, which give a banded appearance to the black or very dark brown body. The larvae and pupae are lemon yellow and are found mostly in the leaf sheaths or the buds. The insect develops from eggs deposited in the plant tissues by the adult female, and the eggs are not visible. Only from 11 to 13 days is required in midsummer for development of the insect from egg to adult.

FIGURE 5.—The gladiolus thrips: Left, adult male; right, female. About 15 times natural size.

Nature of Injury

Injury to the corms. — This thrips feeds on the corms while in storage. The areas that have been fed over become covered with brown corky tissue (fig. 6). All parts of the corm are attacked, including the root initials and, when present, the sprouts. The new corms produced are smaller than those from comparable noninfested planting stock. Hard-shelled cormels or "bulblets" are not susceptible to thrips attack unless the shell has been cracked.

Injury to the growing plants.—After the corms are planted, the thrips follow the sprouts to the surface and there feed and reproduce throughout the season on the foliage and flowers. The infested leaf

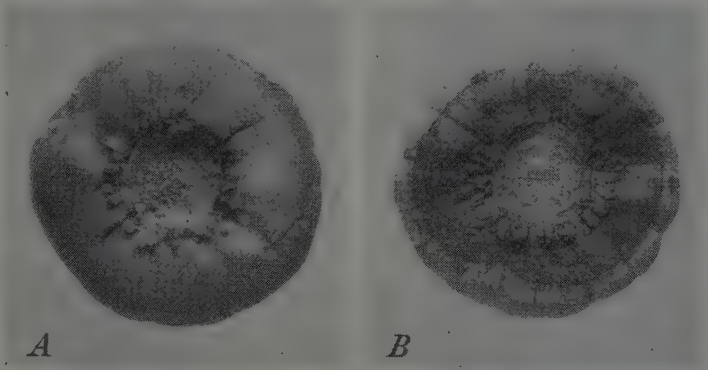

FIGURE 6.—Thrips injury on gladiolus corms: *A*, Uninjured; *B*, injured areas, showing brown corky tissue and dead rootlets.

sheaths become brown, the leaves become silvered (fig. 7, *A*), and the bud sheaths dry out and appear straw-colored. The feeding also injures the petals while still in the bud stage, causing whitish streaks and preventing the normal opening of the flowers (fig. 7, *B*). In severe cases the spikes never show color, but turn brown and appear blighted

For the most part the thrips secrete themselves in the leaf sheaths, but under favorable conditions, such as cloudy days, early in the morning or late in the afternoon, they may be seen on the surface of

FIGURE 7.—*A*, Thrips feeding on gladiolus cause a silvering and browning of the foliage. *B*, Thrips injury on flowers. Note the bleached areas on the petals.

the leaves. For this reason the insects are often not observed until the flowers show damage or unless careful examination is made of the plants.

The habits of this thrips are remarkably suited to the method of growing gladiolus, for it is carried into storage at harvest, feeds on the corms during the winter, and is returned to the field when infested corms are planted. Control should therefore consist of (1) preventing the thrips, as far as possible, from reaching the winter-storage stocks, (2) combating it on the stored corms, and (3), if necessary, applying proper sprays to the growing plants.

Prevention and Control

At harvesttime corm infestation can be reduced by cutting off the tops, but the thrips should not be shaken over the corms in the process; the corms should be removed from the field as soon as possible after they are dug. The tops should be destroyed, by burning if possible, to prevent the thrips from reaching any unharvested part of the crop. The gladiolus thrips apparently does not overwinter out-of-doors in the Northern States but overwinters on the stored corms only. Gladiolus can be planted back in the same field the next season, after an effective corm treatment has been applied, and will not be troubled with the thrips the second year unless reinfested, for example, from untreated corms growing in adjacent plantings. The importance of planting only thrips-free corms is self-evident.

After digging, the corms should be stored in as cool a location as possible, preferably below 50° F., as the thrips are inactive at these temperatures. Temperatures of 32° F. or lower should be avoided. By the time the corms have cured enough to be cleaned they can be treated. Treatment should, however, be deferred until after about November 1, or after a killing frost has occurred, as there is danger of thrips coming in from outside until they have been killed by cold weather. As a further precautionary measure, destroy all discarded corms and other refuse removed from the stock during the cleaning process.

Corm Treatment During the Winter

In those sections of the country where the thrips winters only on the stored corms, it can be controlled most effectively by the proper treatment of the corms. All stock on hand or in a given storage room should be treated with naphthalene flakes at one time, and any corms subsequently acquired should be treated before being stored or planted near the original stock.

The application of naphthalene flakes to the corms is probably the most generally recommended and widely used winter treatment. Flake naphthalene is readily available, cheap, and effective, and it is safe, both for the user and for the corms, even when an overdosage is accidentally used. The flakes should be used at the rate of 1 ounce (4 level tablespoons) for every 100 corms, or 1 pound (1 quart) for 2,000 corms.

For small lots, place the corms in tight paper bags and scatter the flakes over them, then fold the tops of the bags over and fasten them tightly to retain the fumes.

In treating large lots, sprinkle the flakes over and among the corms in the tray and then cover the tray with a light canvas or wrapping paper. The most convenient time to apply the flakes to the corms is directly after they have been cleaned, thereby saving extra labor in handling.

The naphthalene should remain with the corms for about 4 weeks, after which the excess flakes should be shaken out. However, if the treatment is applied late in the fall or early in the winter, the flakes may be left with the corms for 2 months or longer without harm.

A particular advantage of this material is that it can be used with the corms in the storage room without danger to inhabitants in nearby or attached dwellings. Any thrips that may be outside the containers or bulb trays will die before they can reinfest the corms, owing to the long treatment period.

The treatment may be used at any time during the winter, preferably between November 1 and March 1, but it should not be used late in the spring, as it injures the corms severely.

Do not use a covered tin can or other equally tight container, as the corms are likely to sweat and sprout during the treatment.

Corm Treatment at Planting Time

The use of naphthalene flakes during the winter is preferable whenever practicable, but under certain conditions growers may find it necessary to treat their stocks just prior to planting, especially when new stocks are being acquired or if an infestation is not discovered until that time. Under these conditions the corms may be treated with mercuric chloride (corrosive sublimate).

Mercuric chloride.—This chemical, when used as a solution containing 1 ounce to 7½ gallons of water (1 to 1,000), kills all thrips on unpeeled corms left in the dip for 12 to 17 hours. As mercuric chloride dissolves very slowly in cold water, it is advisable to first dissolve it in a small quantity of hot water, then dilute to the correct amount with cold water. Sufficient solution should be prepared so that the corms will be completely submerged. Do not use the same solution a second time but make up a fresh one for each new lot of corms. **Mercuric chloride is deadly poison, and the greatest precautions should be taken in handling it. The use of rubber gloves may be desirable. Because mercuric chloride is corrosive to metals, it should be mixed and used only in glass, earthenware, or wooden vessels.**

For directions as to the use of hydrocyanic-acid gas for the treatment of gladiolus corms, write the Bureau of Entomology and Plant Quarantine, Washington, D. C.

It should be remembered that corm treatment alone does not prevent later reinfestation. It is very essential to isolate untreated corms from treated stock and to avoid carrying thrips from one to the other on clothing, tools, or containers. The refuse from cleaning should be destroyed, and all new stock should be treated before it is stored with any corms that have been disinfected.

Control of Thrips in the Field

If all corms planted have been effectively treated by one of the foregoing methods, the resulting plants should be free of thrips. However, infestations may inadvertently come in from a neighboring untreated planting or may originate from bouquets of infested cut flowers that are consigned to the refuse heap after they have lost their freshness. In such cases spraying should be started immediately.

Since the thrips are difficult to find on the foliage, a careful examination of the plants should be made as soon as they are up 5 to 6 inches, and if any silvered spots are noticed, the plants should be sprayed with a solution of tartar emetic, brown sugar, and water, prepared as indicated below. This solution does not injure the gladiolus foliage as does the paris green and brown sugar combination formerly recommended.

Material:	*Small quantity*	*Large quantity*
Tartar emetic	1 ounce (2 tablespoonfuls)	2 pounds
Brown sugar	2 ounces (6 tablespoonfuls)	4 pounds
Water	3 gallons	100 gallons

The tartar emetic, like the brown sugar, is soluble in water. These ingredients should be stirred in a small quantity of water until dissolved and then diluted up to the quantity desired. No agitation is required with this spray.

Careful spraying, repeated weekly or every 10 days until flowering begins, will do much toward insuring a normal crop of flowers. This can only be accomplished by destroying the insects before they have an opportunity to enter the buds.

To obtain the best results it is necessary to use a sprayer capable of sufficient pressure to produce a fine mist spray that will cover all leaf surfaces of the plants with tiny droplets. Do not apply so much spray that these droplets will unite and run off. If rain occurs within 12 to 24 hours after the application, the spraying should be repeated.

If the spraying has been started early and while the plants are small the infestation should be so greatly reduced that no further treatments need be given after the appearance of the first flowers. However, the last spraying should be so timed that it will be done as close to the beginning of the flowering period as possible.

If it is necessary to continue the spraying during the flowering period, all spikes showing color should be cut before each application.

If spraying for any reason has been delayed until the flower spikes appear, little can be done to save the flowers. In such cases, in order to reduce the number of thrips present and to avoid their possible migration to nearby younger plantings, it is advisable to cut and burn all infested flower spikes wherever practicable.

It is also advisable to plant the early-, midseason-, and late-flowering varieties in separate groups, as this aids in the proper application of sprays.

OTHER SPECIES OF THRIPS

In addition to the gladiolus thrips, at least 11 other species have been observed to feed on gladiolus. Of these, the tobacco thrips (*Frankliniella fusca* (Hinds)), the flower thrips (*F. tritici* (Fitch)), the banded greenhouse thrips (*Hercinothrips femoralis* (Reuter)), and the onion thrips (*Thrips tabaci* (Lind.)) are also capable of doing much damage. The tobacco thrips is often confused with the gladiolus thrips because it is similar in appearance. It usually occurs earlier in the season, and its injury to the foliage is very similar, although the feeding areas are more irregular and is less severe. The control measures recommended for the gladiolus thrips will also control the species mentioned above.

GRAPE MEALYBUG

Gladiolus corms are frequently attacked, especially while in storage, by the grape mealybug (*Pseudococcus maritimus* (Ehrh.)). These small insects, which are covered with a waxy coating having a mealy appearance (fig. 8), cluster around the depressions at the base of the corms and the root buds, where they suck the plant juices and cause the corms to shrink. If such corms are planted, a weakened and stunted growth results, and in some cases the plants fail to grow. Infestation is most likely to occur when gladioli are grown in fields that have previously been in clover or weeds. The insects are brought into storage at harvest time, and, under conditions of storage with temperatures favorable to its development, such as 60° F. or higher, an infestation may increase during the winter so that by spring the corms are literally covered with mealybugs.

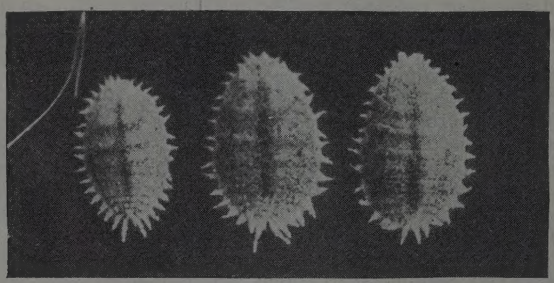

FIGURE 8.—Mealybug adults.

An effective way to kill this insect on the dormant corms is to immerse them in water held at a temperature of 116° F. for 30 minutes. The treating period is calculated from the time the water regains a temperature of 116° after the corms have been placed in the bath. An accurate thermometer should be employed to check the temperature of the water frequently during the treatment. More hot water must be added from time to time as needed to maintain an even temperature. If the corms are to be held for some time, they should be thoroughly dried after treatment, before they are returned to storage. Temperatures above 116° or a longer exposure than 30 minutes may harm the corms.

Commercial growers will probably find it more practical to fumigate the corms in a tight box or chamber with calcium cyanide for a period of 2 hours, using 2 ounces of the granular form for each 100 cubic feet of space. For best results, a temperature of 60° to 70° F. should be maintained within the chamber during the fumigation. **Since hydrocyanic acid gas is a deadly poison, it should be handled only by those familiar with its use. Where the fumigation box is in a room or potting shed, provision should be made for adequate airing of the fumigated corms and the room at the end of each treatment.**

TULIP BULB APHID AND OTHER APHIDS

Another serious pest of dormant gladiolus corms while in storage is the tulip bulb aphid (*Anuraphis tulipae* (Fonsc.)). This aphid seems to be chiefly a root- or bulb-infesting plant louse, because it is rarely found on the leaves. Tulip and iris bulbs are its favored food plants, although it is known to occur on the roots of parsnips, carrots, and wild lettuce. Infestation on gladiolus seems to occur more often when plantings are made in sandy soils in which weeds have been allowed to flourish the previous season or when weeds have been allowed to grow along the edges of gladiolus plantings. In heavy infestations the outer surfaces of the corms become shriveled and are covered with masses of dirty yellowish to grayish waxlike plant lice (fig. 9). These insects extract the vital juices from the corms and kill the new and developing rootlets produced while in storage. As a result, infested corms, when planted, either fail to grow at all, or, if new growth appears, it is sickly and soon withers and dies. Like the grape mealybug, this aphid is brought into storage when the stocks are harvested, and under favorable temperatures it multiplies rapidly so that an infestation soon spreads over all the stored corms.

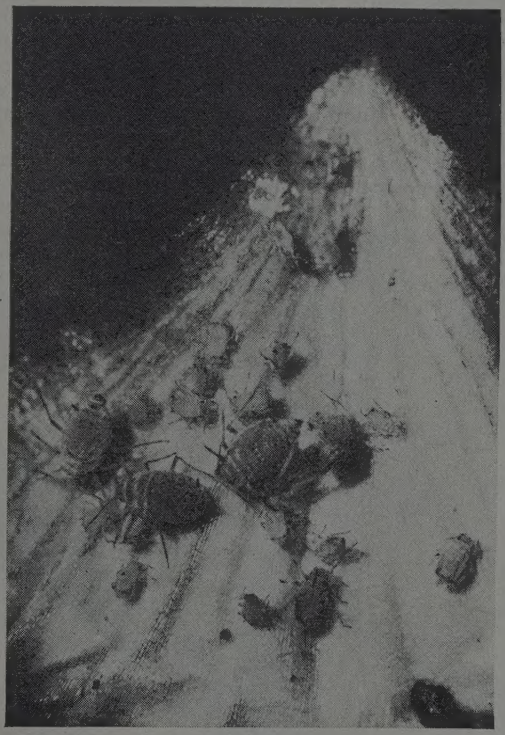

FIGURE 9.—Tulip bulb aphids feeding on a bulb.

Two other species, the green peach aphid (*Myzus persicae* (Sulz.)) and the greenhouse lily aphid (*M. circumflexus* (Buckton)), may also attack corms that are in storage. They usually feed on the young sprouts.

An effective remedy consists of dusting the infested corms thoroughly with a 2-percent nicotine dust and then covering them with a cloth or burlap to confine the fumes for several days.

Naphthalene, as used against the gladiolus thrips, is recommended by some investigators.

Where large quantities of corms need to be treated, calcium cyanide fumigation or the hot-water treatment, as recommended for the control of the grape mealybug, should be used.

Should this aphid or other kinds of aphids appear on the foliage, buds, or flowers, the plants should be sprayed with nicotine or pyrethrum sprays.

A nicotine spray may be prepared by adding a teaspoonful of nicotine sulfate (40 percent nicotine) to a gallon of water in which 2 tablespoonfuls of soap flakes have been dissolved.

A pyrethrum spray may be made by adding 2 teaspoonfuls of a pyrethrum extract (alcoholic extract, 2 percent pyrethrins) to a gallon of water in which 2 tablespoonfuls of soap flakes have been dissolved. Commercial pyrethrum preparations may be used as recommended by the manufacturer.

Under greenhouse conditions frequent fumigation with nicotine smudges or calcium cyanide is recommended. The nicotine preparations should be used as recommended by the manufacturer.

The dosage of calcium cyanide will vary to some degree with the tightness of the greenhouse. From one-eighth to one-fourth of an ounce per 1,000 cubic feet in an overnight exposure is the range of dose recommended. See page 6 for the precautions necessary in the utilization of calcium cyanide.

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